Computing

Lectures	**15 hours**
Labs	**15 hours**

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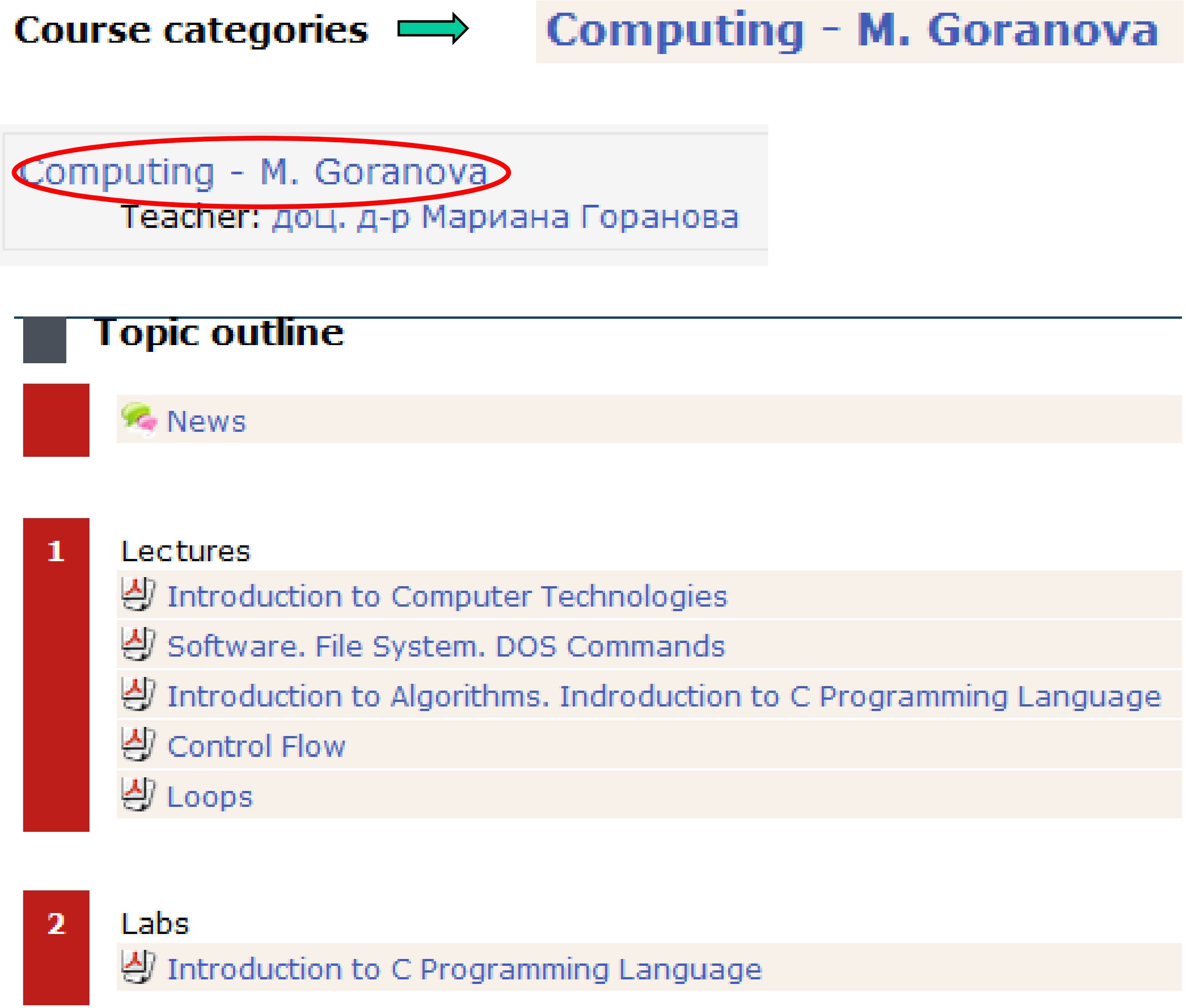

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Topic outline

News

1 Lectures

- Introduction to Computer Technologies
- Software. File System. DOS Commands
- Introduction to Algorithms. Indroduction to C Programming Language
- Control Flow
- Loops

2 Labs

- Introduction to C Programming Language

Bibliography

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Introduction to Computer Technologies

Information,
Information Technologies and
Information Systems

Information = data + value

Information technologies use computer based technologies for information saving, manipulation and transfer.

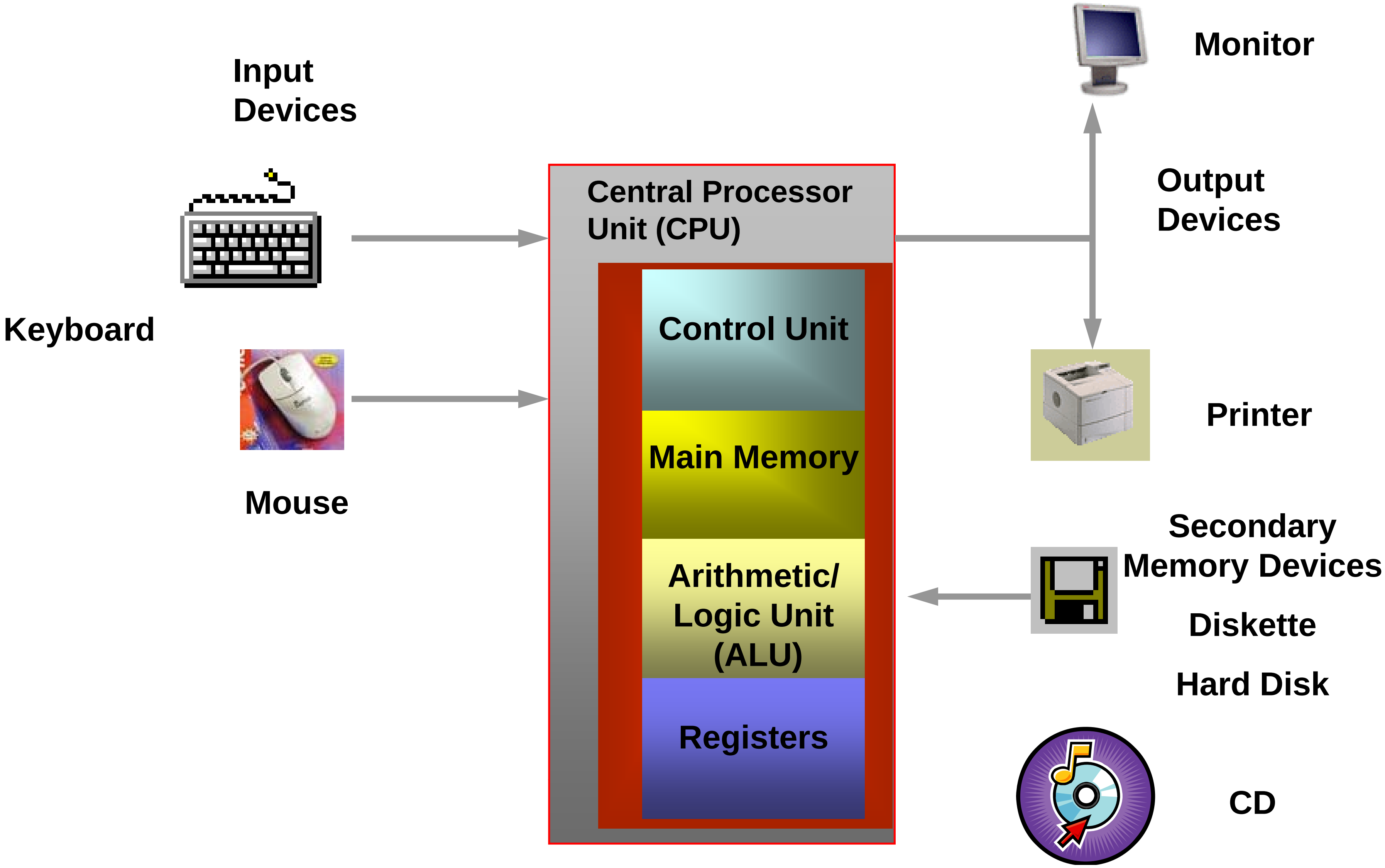
Information systems include human and other resources based on information technologies in a common system for information saving, manipulation and transfer.

Computer System

Computer system consists of hardware and software that work in concern to help us solve problems.

1. **Hardware** – physical pieces that support the computing effort: chips, boxes, wires, keyboards, speakers, disks, cables, plugs, printers, mice, monitors, and so on.
2. **Software** – programs and the data those programs use.
   - **Program** – series of instructions that the hardware executes one after another.

Computer Architecture



Input
Devices

Keyboard

Mouse

Central Processor
Unit (CPU)

Control Unit

Main Memory

Arithmetic/
Logic Unit
(ALU)

Registers

Monitor

Output
Devices

Printer

Secondary
Memory Devices

Diskette

Hard Disk

CD

Program Execution

1. Store the program on secondary memory device (hard disk)
2. Copy the program from secondary memory to main memory
3. CPU repeats
   - reads the program instruction one at a time from main memory
   - brings data from secondary memory or reads from an input device (keyboard)
   - executes the program instruction one at a time
   - displays information to an output device (monitor)

   until the program ends

Hardware Components

1. **Central Processor Unit (CPU)** – executes a program's instructions one at a time.

- **Control Unit** – controls and coordinates the processing steps
- **Main Memory** – stores programs and data
- **Arithmetic and Logic Unit (ALU)** – performs calculations and makes decisions
- **Registers** – provide small storage space in the CPU itself

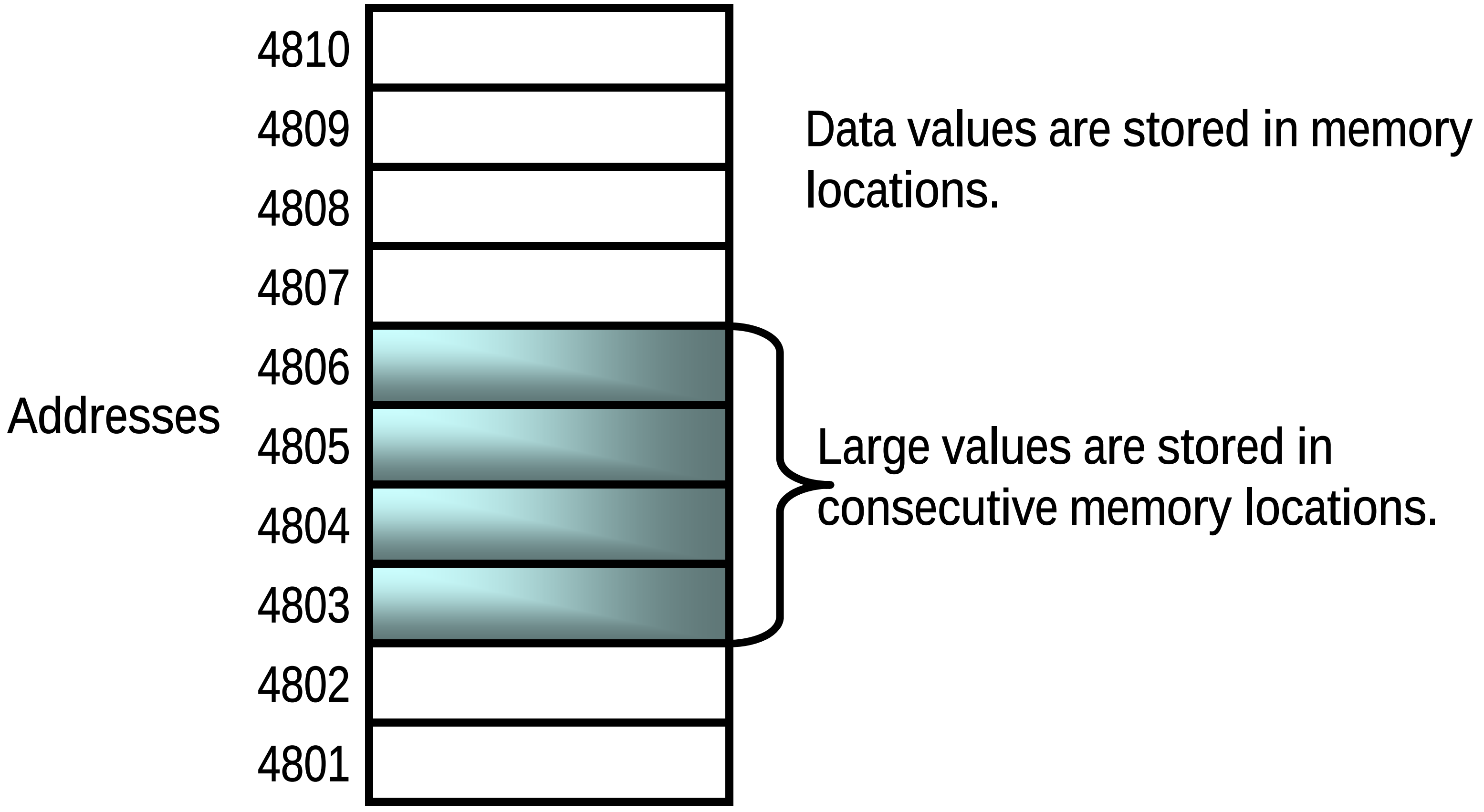
2. **Peripherals** – devices that operate at the periphery

- **Input/output devices** and **secondary memory devices** – they have controllers that coordinate their activities
- **Data transfer devices** – send and receive data between computers (modems)

Information travels between components across a group of wires called **bus**.

Main Memory

Main memory is made up of series of small, consecutive memory locations. Each memory location has a unique number called an address.



Data values are stored in memory locations.

Large values are stored in consecutive memory locations.

Memory locations

Address – a unique number associated with each memory location, used when storing and retrieving data from memory.

Write data to a memory location – overwrites and destroys any information that was previously held in that location.

Read data from a memory location – leaves the value in memory unaffected.

Each memory location holds **1 byte** = **8 bits** of information.

Bit is a single binary digit (0 or 1).

Word is a consecutive bytes and depends on the computer.

2-bytes word = 16 bits   4-bytes word = 32 bits

8-bytes word = 64 bits

Storage capacity of a device – the total number of bytes it can hold.

Unit	Symbol	Number of Bytes
byte	B	2^{0} = 1
kilobyte	KB	2^{10} = 1024
megabyte	MB	2^{20} = 1,048,576
gigabyte	GB	2^{30} = 1,073,741,824
terabyte	TB	2^{40} = 1,099,511,627,776

Units of binary storage

Main memory is volatile – the stored information is only maintained as long as electric power is supplied.

Memory Types:

1) RAM (Random Access Memory) – holds programs and data

2) ROM (Read Only Memory) – holds instruction's code

- programmable from the manufacturer
- PROM – Programmable ROM
- EPROM – Erasable PROM

  UVEPROM – Ultraviolet EPROM

  EEPROM – Electrical EPROM

  Flash

Control Unit

Control unit coordinates:

- **the transfer data and instructions between main memory and the registers**
- **the execution of the circuitry in the ALU to perform a particular operation on data stored in particular registers**

Registers

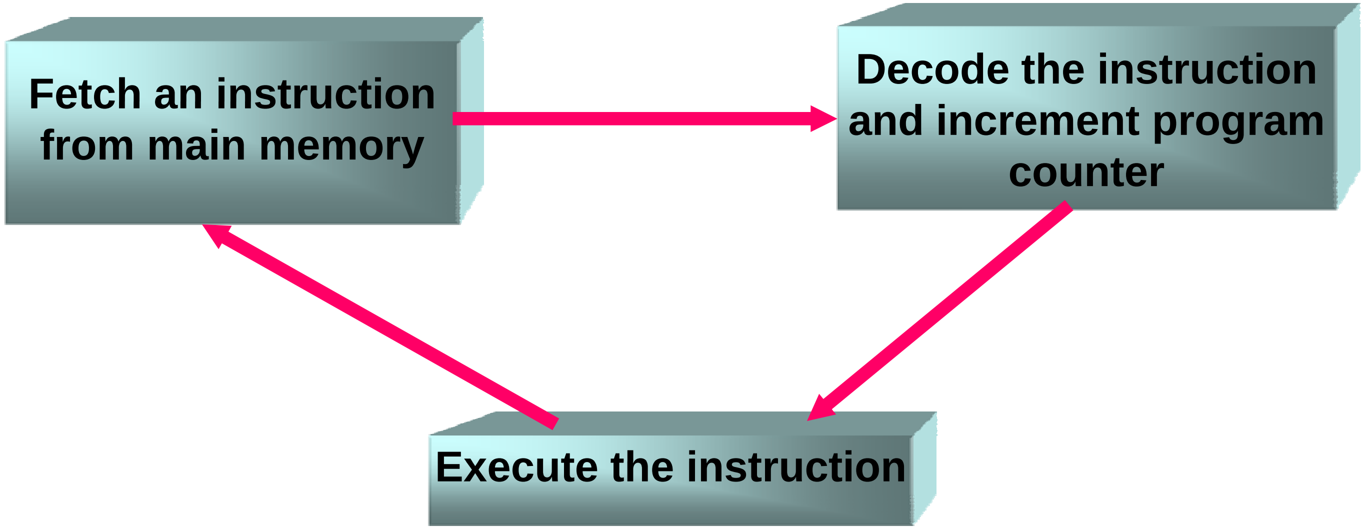
Registers are set aside for special purposes:

- **Instruction register – holds the current instruction being executed**
- **Program counter – holds the address of the next instruction to be executed**

Von Neumann Architecture

The concept of storing both program instruction and data in main memory together is the principle of the von Neumann architecture of computer design (1945).

The computers continually follow the fetch-decode-execute cycle.



Fetch an instruction from main memory

Decode the instruction and increment program counter

Execute the instruction

Microprocessor is a chip that realizes CPU, part of the main circuit board.

System clock generates an electronic pulse at regular intervals, which synchronizes the events of the CPU.

The speed of the system clock indicates how fast the CPU executes instructions.

Secondary Memory Devices

Secondary memory devices are nonvolatile – the information is retained even if the power supply is turned off.

- **hard disk – direct access device**
- **floppy disk**
- **compact disk (CD)**
- **flash disk**
- **magnetic type – sequential access device**

Input/Output Devices

Input/Output devices – input data and output results

- keyboard
- mouse
- light pen
- digitizer
- bar code reader
- joystick
- trackball
- touch pad
- scanner
- microphone
- monitor
- printer
- plotter
- speaker

Computer Classification

1. Microcomputers

- personal computers
- desktop and portable computers:
    - notebook
    - laptop
    - palmtop
- workstations

2. Minicomputers

3. Main frame computers

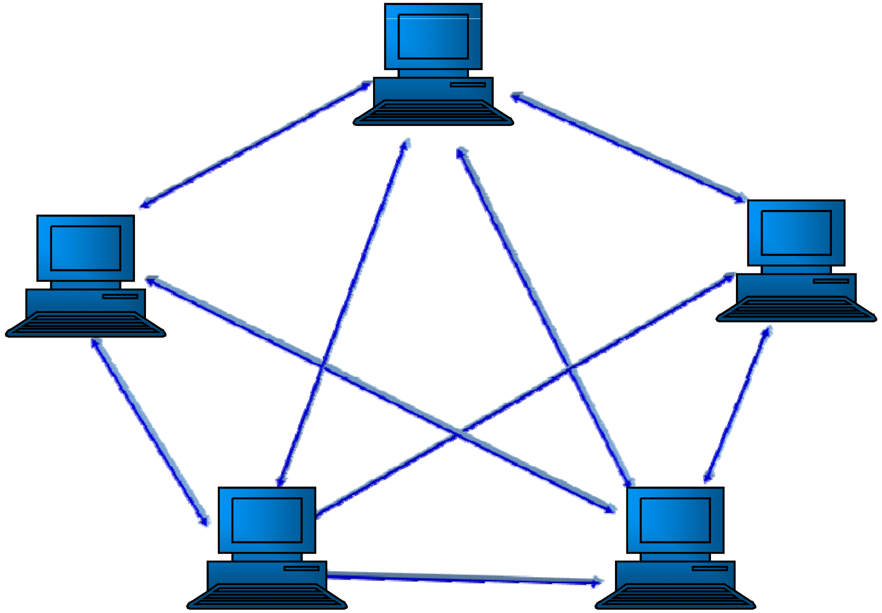
Networks

Network is two or more computers connected together to exchange information.

Network connection

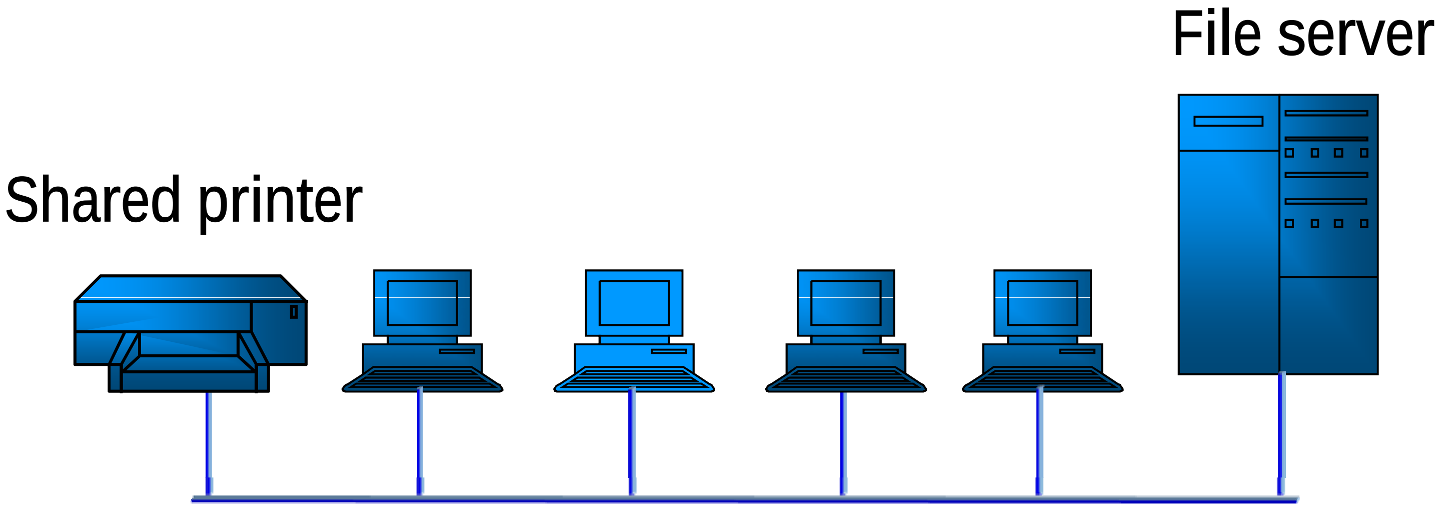
1. **Point-to-point connection**

- **computers are connect directly**
- **used for two geographical close computers**



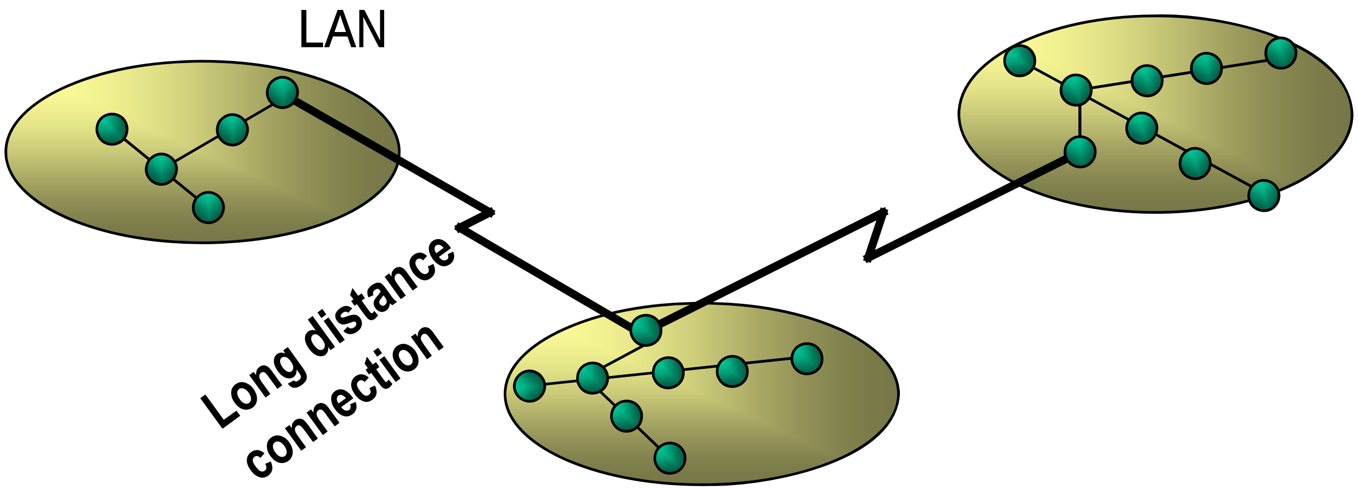
2. Connection with sharing communication line

- all computers share a single communication line
- each computer has its own network address
- used for connecting many computers
- adding new computers to the network is relatively easy



Local-Area and Wide-Area Networks

1. **Local-Area Network (LAN)** – short distances and a relatively small number of computers (in one building, in a single room); inexpensive way to share information and resources throughout an organization
2. **Wide-Area Network (WAN)** – connects two or more LANs, often across long distance



Internet

Internet (internetworking) is a network of networks – connect many smaller heterogeneous networks together.

ARPANET – Advanced Research Projects Agency (US government organization, 1970) Network – wide-area network

Protocol – set of rules that govern how things communicate.

> **TCP/IP** (Transmission Control Protocol/Internet Protocol) – software that governs the movement of messages across the Internet.

IP address – uniquely identifies each computer connected to the Internet.

2004.192.116.2

Internet name of computer – unique for each computer.
Internet name of computer is often referred to as its Internet address.

computer_name.domain_name

Suffix of a domain_name **– indicates the country of origin or the type of organization.**
tu-sofia.bg
pct.tu-sofia.bg

DNS (Domain Name System) – software that translates the Internet address to its corresponding IP address.

Electronic Mail (E-mail)

E-mail – software that sends and receives messages with text, graphics, audio, video, attached files.

E-mail address

user_name@computer_name.domain_name

mgor@tu-sofia.bg
mania@aero.tu-sofia.bg

World Wide Web (WWW)

World Wide Web (WWW) – software that makes sharing information across a network easy.

Hypertext – a way to organize information so that the flow of ideas was not constrained to a linear progression.

Hypermedia – organization incorporated hypertext, graphics, audio and video.

Browser – software tool that loads and formats Web documents for viewing. The documents are often written using the HyperText Markup Language (HTML).

- Mosaic
- Netscape Navigator
- Internet Explorer

Uniform Resource Locators (URL)

Uniform Resource Locators (URL) – uniquely specifies documents and other information on the WWW for a browser to obtain and display.

protocol://Internet_address/file_name

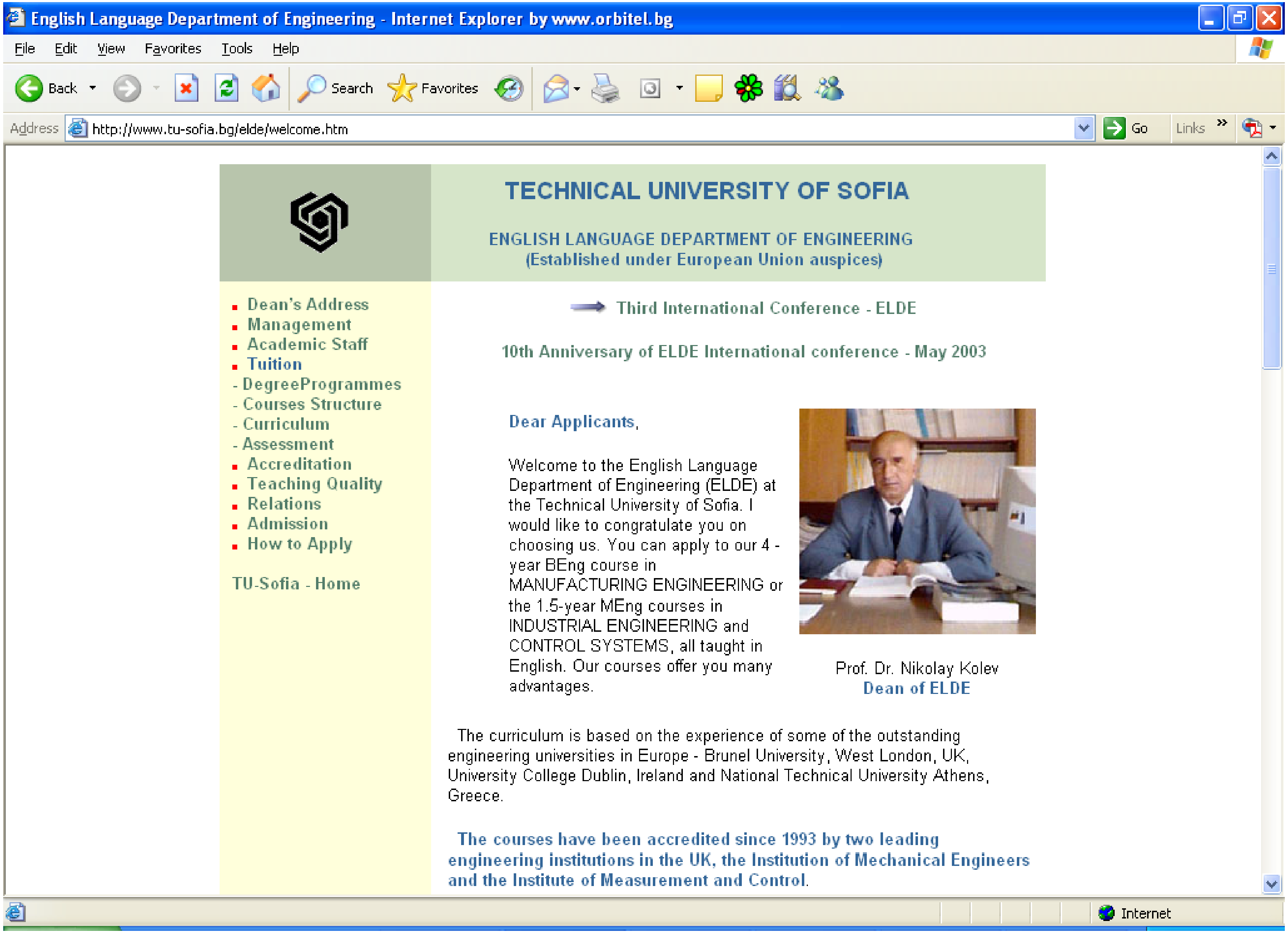
If no file_name **is given browsers make the default selection (**default.html **or** default.htm**).**

http://www.yahoo.com

http://www.tu-sofia.bg

http://mmt.tu-sofia.bg/MGoranova/

http://www.tu-sofia.bg/elde/welcome.htm



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Number Systems

$A=a_nS^n+a_{n-1}S^{n-1}+\ldots+a_1S^1+a_0S^0+a_{-1}S^{-1}+a_{-2}S^{-2}+\ldots$

A – **number in the number system**

a – **digit of the number system**

S – **base of the number system**

i – **position of digit**

S^i – **place value – determined by the base of the number system, raised to increasing powers as we move from right to left**

Decimal number system

- base-10
- 10 digits: (0 through 9)

Binary number system

- base-2
- 2 digits (0 and 1 – bit (binary digit))

Hexadecimal number system

- base-16
- 16 digits (0 through 15: 0,1,…,9,A,B,C,D,E,F)

Octal number system

- base-8
- 8 digits (0 through 7)

Place value	$2^7=128$	$2^6=64$	$2^5=32$	$2^4=16$	$2^3=8$	$2^2=4$	$2^1=2$	$2^0=1$
Position	7	6	5	4	3	2	1	0

Place value:	10^3=1000	10^2=100	10^1=10	10^0=1
Decimal number:	8	4	2	7

Decimal number: $8 * 10^3 + 4 * 10^2 + 2 * 10^1 + 7 * 10^0 =$

$8 * 1000 + 4 * 100 + 2 * 10 + 7 * 1 = 8427$

Place value:	2^3=8	2^2=4	2^1=2	2^0=1
Binary number:	1	1	0	1

Decimal number: $1 * 2^3 + 1 * 2^2 + 0 * 2^1 + 1 * 2^0 =$

$1 * 8 + 1 * 4 + 0 * 2 + 1 * 1 = 13$

Place value:	16^3=4096	16^2=256	16^1=16	16^0=1
Hexadecimal number:	2	A	8	E

Decimal number: $2 * 16^3 + 10 * 16^2 + 8 * 16^1 + 14 * 16^0 =$

$2 * 4096 + 10 * 256 + 8 * 16 + 14 * 1 = 10894$

Binary (base 2)	Octal (base 8)	Decimal (base 10)	Hexadecimal (base 16)
0	0	0	0
1	1	1	1
10	2	2	2
11	3	3	3
100	4	4	4
101	5	5	5
110	6	6	6
111	7	7	7
1000	10	8	8
1001	11	9	9
1010	12	10	A
1011	13	11	B
1100	14	12	C
1101	15	13	D
1110	16	14	E
1111	17	15	F

Conversions a Base-10 Integer Value to a Base-S Value

Algorithm

```
set the lowest digit position to zero, $i=0$
repeat
    divide the number A by the base S and find the quotient $R = A / S$
    assign the remainder to the lowest digit, $a_i = A – R . A$
    assign the quotient R to the number, $A = R$
    set the next digit position, $i = i + 1$
until the quotient $R > 0$
```

$57_{10}=?_2$

$i = 0$	$R = 57 / 2 = 28$	$a_0=57-28.2=1$	$A = 28$
$i = 1$	$R = 28 / 2 = 14$	$a_1=28-14.2=0$	$A = 14$
$i = 2$	$R = 14 / 2 = 7$	$a_2=14-7.2=0$	$A = 7$
$i = 3$	$R = 7 / 2 = 3$	$a_3=7-3.2=1$	$A = 3$
$i = 4$	$R = 3 / 2 = 1$	$a_4=3-1.2=1$	$A = 1$
$i = 5$	$R = 1 / 2 = 0$	$a_5=1-0.2=1$	$A = 0$

$57_{10}=111001_2$

$57_{10}=?_{16}$

$i = 0$	$R = 57 / 16 = 3$	$a_0=57-3.16=9$	$A=3$
$i = 1$	$R = 3 / 16 = 0$	$a_1=3-0.16=3$	$A=0$

$57_{10}=39_{16}$

Conversion a Base-10 Regular Fraction to Base-S Regular Fraction

Algorithm

```
set the highest digit position to -1, $i = -1$
repeat
    multiply the number A with the base S and find the product $P = A . S$
    assign the integer part of the product to the highest digit, $a_i$ = integer part (P)
    assign the fractional part of the product to the number A, A = fractional part (P)
    set the next digit position, $i = i - 1$
until the number $A > 0$
```

$0{,}25_{10}=?_2$

$i = -1$ $R = 0{,}25 \,.\, 2 = 0{,}5$ $a_{-1}=0$ $A = 0{,}5$

$i = -2$ $R = 0{,}5 \,.2 = 1{,}0$ $a_{-2}=1$ $A = 0$

$0{,}25_{10}=0{,}01_2$

$0{,}25_{10}=?_{16}$

$i = -1$ $R = 0{,}25 \,.\, 16 = 4{,}0$ $a_{-1}=4$ $A = 0$

$0{,}25_{10}=0{,}4_{16}$

$57{,}25_{10}=111001{,}01_2$

$57{,}25_{10}=39{,}4_{16}$

Shortcut Conversions

Bases that are powers of 2 (binary, octal and hexadecimal) allow very quick conversions between them.

1. **Conversion from binary to hexadecimal**

- **group the bits into group of four ($2^4 = 16$), starting from the right**
- **convert each group of four into a single hexadecimal digit**

$$\underbrace{101}_{5}\underbrace{1111}_{F}\underbrace{1011}_{B}\underbrace{0011}_{3}$$

101111110110011_2=5FB2$_{16}$

2. **Conversion from hexadecimal to binary**

- **expand each hexadecimal digit into four binary digits**
- **add leading zeros to the binary version of each expanded hexadecimal digit if necessary**

$$\overbrace{0100}^{4}\overbrace{0000}^{0}\overbrace{1100}^{C}\overbrace{0110}^{6} \qquad 40C6_{16}=100000011000110_{2}$$

3. **Conversion from binary to octal**

- **group the bits into group of three ($2^3 = 8$), starting from the right**
- **convert each group of three into a single octal digit**

4. **Conversion from octal to binary**

- **expand each octal digit into three binary digits**
- **add leading zeros to the binary version of each expanded octal digit if necessary**

5. **Conversion from hexadecimal to octal – two shortcut conversions**

- **from hexadecimal to binary**
- **from binary to octal**

6. **Conversion from octal to hexadecimal – two shortcut conversions**

- **from octal to binary**
- **from binary to hexadecimal**